The Multifunctional Nanocomposites for Theragnosis

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The successful medical practices comprise early and accurate diagnosis of disease, patient condition-specific treatment, accurate assessment of the treatment, and application of preventive measures against potential complications after cure. While personalized medicine, ideally, refers to medical care taylor-suited to individual patients, patients are, in practice, segmented to several subgroups under a general disease; for example, breast cancer patients are catalogued into several subgroups depending on molecular markers and/or signatures reflecting underlying tumor biology as well as anatomical staging and the patients within a subgroup would be subjected to the same treatment including conventional and/or molecularly targeted therapy. Notably, many of these fields are greatly benefited by recent developments in nanotechnology. While cancer remains as a major medical challenge, recent years we saw a decrease in the mortality due to better understanding of tumor biology and improved diagnostic devices and treatment. Catalogued patients following both tumor biology driven and classical anatomy-driven classification are subjected to personalized cancer therapy, namely administration of patient condition-specific drugs (molecularly targeted drugs) along with other conventional therapies including chemo-/radio-therapy or surgery. While this new paradigm shift in cancer treatment and recent success leading to mortality decrease are very welcome, there remain a number of great huddles to be overcome for successful cancer treatment; accordingly, the recent nanomedicinal technological advances are focused on topics such as simultaneous multimodal imaging to document molecular events for accurate patient cataloguing at earliest possible stage, simultaneous diagnosis and treatment for early intervention, drug targeting and release control to circumvent multiple-drug resistance, and etc. These advances invariably adopt nanocomposites with multiple functions incorporated, because biologically relevant nanocomposites with their relatively large size of 3~200 nm under physiological conditions, as compared to molecular drugs, can easily take various payloads of chemicals and nano-objects for desirable functions like molecular imaging and cancer-killing.

In this talk, I describe some of functional components in the bio/medicinal nanocomposites as well as their required properties, and, furthermore, noteworthy recent advances in the formulation of multifunctional nanocomposites which led to great technological thrusts are introduced. Finally, I offer an outlook on the direction which this field is heading to and technical huddles which should be overcome for successful biomedical applications.